The Evolution of ED Crowding

Authors: Aaron A. Bellow Jr., MSN, APRN, CEN, FNP-BC, and Gordon Lee Gillespie, PhD, RN, PHCNS-BC, CEN, CPEN, FAEN, Beaumont, TX, Pittsburgh, PA, Cincinnati, OH

ED crowding, a condition that occurs when the need for emergency services outstrips the available resources in the emergency department, is a contemporary issue of high importance to ED leaders.[1] ED crowding has been discussed in the literature for more than 20 years. The phenomenon was first introduced in the late 1980s, but it was not until the early 1990s that professional organizations such as the American College of Emergency Physicians (ACEP) began issuing position statements.[2] In 2003 the General Accounting Office (GAO), commissioned by the U.S. Senate Committee on Finance, completed a national study of emergency departments. The study concluded that most hospitals experienced ED crowding to some degree, but the majority of crowding was confined to geographical areas with large populations, large recent population growth, and higher than average numbers of uninsured patients.[3] A follow-up report by the GAO in 2009 concluded that ED crowding continues to occur nationally and that wait times in the ED increased, in some cases exceeding the recommended time to see a provider based on acuity level.[4] These reports highlight the significance of ED crowding as a nationwide phenomenon affecting emergency departments across the United States, with the potential to negatively affect the quality of care that ED patients receive.

Purpose

ED crowding has evolved from a phenomenon initially believed to be limited to large academic medical facilities in highly populated urban areas to a nationwide health care problem plaguing urban, suburban, and even some rural emergency departments. As the problem of ED crowding continues to evolve, so have discussions of the phenomenon. Early discussions focused on defining ED crowding and identifying its contributing factors and associated attributes. As the discussion grew, a broader view of the concept led to the recognition of ED crowding as a symptom of a larger issue of impaired patient flow in health care facilities, and the conversation shifted toward facility-wide efficiency with less focus on intradepartmental efficiency. Finally, although many attempts have been made to eliminate ED crowding altogether, most facilities continue to grapple with the issue, and concerns about quality of care during periods of ED crowding led to a renewed focus on intradepartmental efficiency. The purpose of this article is to provide a historical overview of ED crowding to illustrate how the phenomenon has evolved over time and to articulate the shifts in focus that have occurred along the way.

Defining ED Crowding

The historic GAO report (2003) on ED crowding revealed that crowding is a complex issue, with hospitals reporting that they "know it when they see it."[3] A better definition was provided by ACEP: A situation in which the identified need for emergency services outstrips available resources in the emergency department, hospital, or both.[1] Although the GAO did not provide a specific definition for ED crowding, the GAO report did offer several factors that likely identify when an emergency department is crowded, although it does not explain why ED crowding occurs.[3] Five factors are associated with ED crowding: diversion, boarding, increase in patients leaving without treatment, higher than usual number of patients awaiting treatment, and higher than usual waiting times. These factors can be used to define when an emergency department is crowded and to distinguish periods of crowding from periods of excess patient volume resulting in congestion. It is likely that congestion precedes crowding when these same factors occur to a lesser extent.

IDENTIFYING ED CROWDING

The GAO report identified 3 factors that are consistently associated with ED crowding: (1) *diversion*, the term used to describe a hospital's request that EMS bypass the emergency

Aaron A. Bellow Jr, *Member, Golden Triangle Chapter,* is Nurse Practitioner, The Schumacher Group, Christus Gulf Coast Facilities Emergency and Minor Care Departments, Beaumont, TX, and PhD Student, Duquesne University, Pittsburgh, PA.

Gordon Lee Gillespie, *Member, Greater Cincinnati Chapter,* is Assistant Professor, University of Cincinnati College of Nursing, Cincinnati, OH.

For correspondence, write: Aaron A. Bellow Jr, MSN, APRN, CEN, FNP-BC, 200 Corporate Blvd, Ste 210, Lafayette, LA 70598; E-mail: aaronbellow@yahoo.com.

J Emerg Nurs 2014;40:153-60.

Available online 6 March 2013.

0099-1767/$36.00

Copyright © 2014 Emergency Nurses Association. Published by Elsevier Inc. All rights reserved.

http://dx.doi.org/10.1016/j.jen.2013.01.013

department and divert patients to another facility; (2) *boarding*, the term used to describe patients who remain in the emergency department after a decision is made to admit or transfer the patient because of some issue(s) inhibiting the admission or transfer; and (3) *left without treatment*, the term used to describe a select group of patients who ask to be evaluated in the emergency department but ultimately choose to leave before medical evaluation, usually because of extended wait times.[3] Because virtually every emergency department will have patients who leave before medical evaluation regardless of wait times or ED crowding, it is more reasonable to identify an increase from baseline in the number of patients leaving before medical evaluation as a defining attribute of ED crowding.

In addition to the aforementioned factors, ACEP's white paper on ED crowding can also offer additional factors associated with ED crowding.[1] According to ACEP, ED crowding occurs when there are more patients than staffed ED treatment beds and when wait times exceed a reasonable period. Additional factors in ED crowding include a higher than usual number of patients awaiting treatment and extended waiting times based on what would be normal or traditional patient volumes and waiting times for a specific emergency department.[1]

Although patients who leave before medical evaluation could be an indirect indicator of high patient volumes and extended waiting times, emergency departments can theoretically experience high patient volumes and excessive waiting times without having high numbers of patients leaving before medical evaluation because the choice to leave is often affected by patients' perceptions of their degree of illness. In other words, it is possible that patients who perceive themselves to be very sick and in need of medical attention may stay for treatment in spite of the extended waiting times associated with ED crowding.

Contributing Factors of ED Crowding

Identifying factors that contribute to ED crowding is important to understand this complex phenomenon that results when individual patient care delivery units, both emergency departments and inpatient units, interact within the hospital system. Richards and colleagues[5] list multiple factors they identify as common factors contributing to ED crowding:

- Increased complexity and acuity of patients
- Overall increase in patient volume
- Decreased access to primary care providers
- Lack of inpatient beds for admitted patients
- Avoidance of inpatient admission by providing intensive ED therapy
- Delays in service due to ancillary service providers such as laboratory and radiology
- Shortage of nursing staff
- Shortage of administrative/clerical support
- Shortage of on-call consultants
- Shortage of physical plant space limiting the number of ED beds
- Language and culture barriers between physicians and patients that result in longer ED visits
- Shortage of house staff completing ED rotations in teaching hospitals
- Increased documentation requirements
- Difficulty arranging follow-up care

Solberg and colleagues[6] also identified factors contributing to ED crowding:

- Patient demand: The volume of patients presenting to the emergency department for medical care
- Patient complexity: The urgency and potential seriousness of the complaint
- ED capacity: The ability of the emergency department to meet patient demand according to adequacy of physical space, equipment, personnel, and organizational system
- ED workload: The patient demand created within a given period
- ED efficiency: The ability of the emergency department to provide timely, high-quality emergency care while limiting waste of supplies, effort, equipment, and time
- Hospital capacity: The ability of the hospital to meet patient demand according to adequacy of physical space, equipment, and personnel
- Hospital efficiency: The ability of the hospital to provide timely, high-quality care while limiting waste of supplies, effort, equipment, and time

Although the preceding lists are largely based on anecdotal observations and assessments, they have been presented because of their inclusive nature in helping to identify potential causes and contributing factors to ED crowding that are important for gaining a comprehensive understanding of the problem.

Measurement of ED Crowding

Multiple attempts have been made to identify universally accepted measurements of ED crowding.[2,7–12] Direct and indirect measures of ED crowding have been attempted by quantifying the frequency of occurrences of common

associated factors such as ambulance diversion and patient boarding in the emergency department.[7,12,13] No consensus measurement of ED crowding has been established. Attempts to identify an absolute reference standard for the quantification and measurement of ED crowding have all been thwarted by perceptual and operational variations that prevent any meaningful multisite comparisons. Instead, what has emerged is a universal focus on performance-based measures consistently associated with ED efficiency that may be negatively affected during periods of ED crowding. Consistent with this theme, ENA published a consensus statement in 2012 offering definitions for consistent ED metrics.[14]

Conceptual Models of ED Crowding

Although attempts to develop universally accepted quantification of ED crowding have not resulted in any consensus measures, conceptual models of ED crowding have largely been embraced as a useful mechanism for explaining this complex phenomenon. Two models have been proposed to help explain ED overcrowding: the Cardiac Analogy Model and the Input, Throughput, Output Model of ED Crowding.

CARDIAC ANALOGY MODEL

Laskowski-Jones[15] proposed using a cardiac analogy model as a way to conceptualize ED crowding. Laskowski-Jones[15] summarized that as preload increases, cardiac output also increases up to a certain point, beyond which the myocardial fibers are overstretched and any further increase leads to a decrease in cardiac output. Using this model, cardiac output is analogous to overall ED system performance including throughput, patient and staff satisfaction, and quality of care. Heart rate is analogous to the rate at which the staff works. Stroke volume is analogous to the total amount of productive work in a given period and is dependent on preload, afterload, and contractility. Preload can be viewed as the number of patients requesting services. Afterload reflects any resistance to ED outflow such as delays in inpatient bed availability. Contractility is comparable to the flexibility of the ED staff responding to rapidly changing work conditions.

According to this model, ED crowding can be viewed as ED system performance failure and is based on an interaction of several factors. The efficiency of the ED staff and the underlying design process determines the rate at which staff respond to any demands for services (preload). When demand is too great, the staff is overstretched. Although the rate at which ED staff work increases, the overall efficiency decreases, resulting in diminished ED system performance. Likewise, whenever the ED staff encounters resistance to ED outflow (increased afterload), such as a lack of availability of inpatient beds or the inability of the admitting nurse to receive report on admitted patients, ED system performance also diminishes, resulting in ED crowding.

Although this cardiac analogy model proved helpful in conceptualizing ED crowding, it limits the discussion to medical personnel who have an in-depth understanding of the pathophysiology of heart failure. Because of this limited usefulness, this model has not been used as frequently as the Input-Throughput-Output Model of ED Crowding.

INPUT, THROUGHPUT, AND OUTPUT MODEL

Asplin and colleagues[16] provided a conceptual model of ED crowding to aid in the development of potential solutions. The authors conceptualized ED crowding by applying operations management processes to potential ED crowding factors in an effort to provide organizational structure to this multidimensional problem. The resulting conceptual framework is successful at categorizing factors associated with ED crowding into 3 interdependent components: input, throughput, and output.

The input component consists of the patients who present to the emergency department for care and represents the demand on the system (e.g., patient demand and patient complexity). Factors associated with demand for ED services include geographical demographics, patient health status, patient insurance status, and availability of emergency care alternatives, including urgent and primary care.[16]

The throughput component consists of factors associated with patient length of stay within the emergency department and focuses on the need to improve internal care processes (e.g., ED capacity, ED workload, and ED efficiency). Processes that influence throughput in the emergency department include triage and registration processes, care procedures, staffing, availability of on-call specialists, and availability of diagnostic services.[16]

Asplin and colleagues[16] further define the output component as consisting of factors that affect the disposition of ED patients who have been selected for admission or transfer (e.g., hospital capacity and hospital efficiency). This component of the model highlights the issues contributing to ED crowding that are external to the emergency department and thus indicate the need to view ED crowding from a system perspective. Output is affected by inpatient bed capacity, admission and discharge processes, and operating room availability at the admitting facility.

The Input-Throughput-Output framework helped to classify the multifaceted concept of ED crowding. Segmenting the elements of ED crowding in this manner proves useful in discussing specific features of this complex topic. Consequently, the issue of extradepartmental output factors that contribute significantly to ED crowding by necessitating the holding of admitted patients within the emergency department (boarding) led to a shift in focus away from the emergency department as the primary source and solution to ED crowding.[17] ED crowding is now being viewed as a problem of patient flow within the greater context of system issues that affect efficiency within the health care system. This paradigm shift has proven useful and effective at advancing the discussion of patient flow in acute care settings.

Shifting to Patient Flow

Patient flow in acute care settings has become a focus of many organizations that are concerned about the quality and cost of health care.[18,19] The crisis of (ED) crowding and its associated factors have created a heightened sense of awareness in relation to meeting the demands for service. The inability of facilities to adequately respond to patient demand has highlighted the highly significant issue of limited resources.[20] Every institution must adequately allocate a finite amount of resources so that institution can fulfill its mission now and in the future. Many of today's health care institutions once thrived in a pre–managed care environment where additional resources could easily be added to address the ever-increasing needs of their patient populations.[20] Today, most organizations are faced with a limited amount of fiscal and human resources that they must adequately manage to meet patient needs at a time when those needs seem to be increasing exponentially because of the aging of the population, chronicity of illnesses, and advances in medical technology, all of which lead to a high-acuity, high-demand, resource-dependent customer base.

This environment of limited resources has caused the questioning of the efficiency and productivity of the health care industry.[21] Long waits and excessive delays were once thought to be an inevitable part of a system fraught with unpredictability and unavoidable variability. Attempts are now being made in health care to predict the unpredictability and to limit the variability in hopes of increasing productivity and efficiency.[20] The area of patient flow has gained popularity as bottlenecks leading to unnecessary delays in care are being explored in an attempt to identify root causes that are responsible for some of the perceived inadequacy of resources within the system.

Organizational Support for Improving Patient Flow

Organizational support for improving patient flow is significant because the support of organizations that focus on health care quality and patient safety illustrates the important role of patient flow in the health care system. The involvement of organization like the Robert Woods Johnson Foundation, The Joint Commission, and the Institute for Healthcare Improvement has contributed to a growing understanding of the impact of patient flow within the health care system.

ROBERT WOOD JOHNSON FOUNDATION

Urgent Matters is a $6.4 million initiative sponsored by the Robert Wood Johnson Foundation aimed at relieving ED crowding in safety net hospitals. Safety net hospitals are hospitals that, by history or mission, provide a significant amount of care to underinsured or uninsured patients and have difficulty covering the cost of care from their own resources.[22] *Urgent Matters* has 3 specific goals:

- Improve the ability of safety net providers to respond to increasing ED volumes
- Assess and highlight the state of local safety net hospitals in select communities
- Publicize outcomes to local and national audiences

McClelland and colleagues[23] highlighted the lessons learned from a decade of work on ED crowding by *Urgent Matters*. In addition to the development of learning networks through hospital collaboratives and a collection of ED-specific strategies and interventions to target ED crowding, *Urgent Matters* has been instrumental in the development of ED performance measures essential in measuring operational performance and quality improvement. Perhaps the most important contribution of the initiative is the development of the *Urgent Matters* Seven Success Factors, which now provide the basis for all *Urgent Matters* activities. The *Urgent Matters* Seven Success Factors are:

- Recognition that ED crowding is a hospital-wide patient flow problem that is not confined to the emergency department.
- Multidisciplinary, hospital-wide teams are required for successful implementation of changes.

- A champion with power and influence must be appointed to continuously advocate for change.
- Executive commitment is necessary to address the organizational barriers to patient flow.
- A formal process improvement method must be identified and used to continuously and quickly implement and evaluate change using the momentum of prior successes to prevent stagnation of progress.
- Rigorous metrics must be employed because success is dependent on measurement.
- Improvement is dependent on the open communication of objective evidence of positive change with staff.

These factors illustrate the importance of a hospital-wide commitment to the improvement of patient flow. It is reasonable to begin to address inefficiencies at the ED level because the emergency department serves as the point of access for a large number of patients and is most prone to the compounding effect of inefficiencies resulting in patient congestion and crowding. However, intradepartmental changes within the emergency department have a limited impact on overall hospital patient flow. The issue must be addressed within the greater context of organizational management and system-wide care processes that are the true sources of inefficiency.[24]

THE JOINT COMMISSION

The Joint Commission developed a leadership standard calling for hospital leaders to address issues that contribute to inefficient movement of patients within an organization. This standard promotes the shared accountability of leaders and medical staff to develop processes that support efficient patient flow throughout the entire hospital. According to The Joint Commission, problems with patient flow can lead to congestion and sentinel events resulting from delays in treatment. To understand the broad implications of patient flow within a system, leaders are expected to assess patient flow in relation to capacity, efficiency, quality, and safety.[19]

INSTITUTE FOR HEALTHCARE IMPROVEMENT

The Institute for Healthcare Improvement (IHI) is a nonprofit organization based in Cambridge, Massachusetts. The IHI describes itself as a reliable source of energy, knowledge, and support for a never-ending campaign to improve health care worldwide. The IHI proposes measurable and continual progress in health care systems with an emphasis on safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity. The IHI lists patient flow as one of its core topics and provides resources on its Web site and through publications to assist acute care organizations in addressing patient flow.[18]

Variability and Patient Flow

Litvak and colleagues[20] identified three major system level stressors inherent in health care delivery systems:

- Flow stress: The stress associated with variability in patient volume
- Clinical stress: The stress associated with variability in patient acuity
- Professional stress: The stress associated with variability in the professional ability and competing responsibilities of health care workers

All three stressors are associated with variability that reflects a fluctuation in the demand that health professionals must meet to provide safe and effective care. Although clinical and professional stresses are important, the following discussion will focus on the variability associated with flow stress.

Variation in patient volume is an accepted aspect of care in today's health care environment. There is an expectation that patient census fluctuates creating a peak and trough pattern that is patient driven, unpredictable, and uncontrollable. Consequently, hospitals traditionally attempt to staff for patient demand in order to ensure that patients receive adequate care while at their facility. Thus variability in patient demand in conjunction with a limited supply of human and fiscal resources inevitably results in periods of inadequacy.[20]

Because of the relationship of demand variability to flow stress, many experts are beginning to further explore variability as an important concept in understanding patient flow. According to Litvak and colleagues,[20] daily census variability can be further categorized into natural variability (ie, uncontrollable and random) and artificial variability (ie, potentially controllable, nonrandom, and unnecessary). Natural variability is associated with the aspect of variability that is extrinsically created and cannot be controlled, such as patient arrivals to the emergency department. Artificial variability is associated with the aspect of variability that is intrinsically created and can at least be manipulated and predicted, if not controlled. An example of artificial variability is the elective surgery schedule that creates demand for inpatient beds, thus decreasing bed availability for admitted ED patients and creating an environment where boarding of admitted patients in the emergency department is a frequent occurrence. By categorizing

variability in this manner, Litvak and colleagues[20] illustrate that a very important aspect of patient flow and the variability that creates flow stress can be addressed through organizational management.

Using organizational management techniques to limit or eliminate variability is an important step in managing patient flow. Reduction of variability enables more adequate use of available resources and prevents waste by creating a more stable, consistent pattern of demand. Methods to address artificial variability should be used to eliminate unnecessary peaks in demand for inpatient beds. Statistical analysis (eg, Queuing Theory and Census Models) also can be used to better understand natural variability and provide adequate resources to meet expected demand.[25,26]

Regardless of where an organization chooses to focus its efforts to improve patient flow, understanding natural and artificial variability is vital to creating sustained efficiency. To fully understand variability, organizations must employ systems thinking, where hospital units are viewed as interdependent compartments within a larger interrelated system versus independent departments existing in isolation to one another. Considering the impact of the elective surgery schedule on the demand for inpatient beds and the effect of that demand on the ability to move admitted patients out of the emergency department is an example of the systems thinking necessary to adequately address flow stress as an aspect of organizational improvement.

After years of institutional focus on hospital-wide patient flow, many organizations have seen considerable improvements in ambulance diversion and boarding times. However, a large number of institutions are still experiencing periods of ED crowding and extended waiting times.[4] Much as the Input-Throughput-Output conceptualization of ED crowding led to a shift to focusing on hospital-wide patient flow versus the emergency department in isolation, the persistent problem of ED crowding in spite of system-wide solutions to improve patient flow has led to a renewed focus on maintaining quality of care in the emergency department despite continued periods of ED crowding.[27] The potential for diminished quality of care during periods of ED crowding has ushered in another shift in focus toward intradepartmental ED efficiency.

Shifting to ED Efficiency and Quality of Care

In June 2011, *Academic Emergency Medicine*, the official journal of the Society for Academic Emergency Medicine, sponsored a conference with the twofold goal of developing research agendas focused on investigating interventions to safeguard quality of care during periods of ED crowding and identifying system-wide solutions that can be used to reduce crowding altogether. Both goals were achieved through 3 objectives:

- Review and summarize the effectiveness of ED crowding interventions that have already been implemented
- Explore strategies within the health care setting, as well as other disciplines (eg, engineering, operations management, and systems design) that may reduce ED crowding or improve care during periods of ED crowding
- Identify the most appropriate approach in terms of analytic design and techniques to explore ED crowding interventions and solutions[27]

As a result of a breakout session at the Academic Emergency Medicine Conference on Interventions to Assure Quality in the Crowded ED, Ward and colleagues[28] explored the concept of efficiency as a quality indicator during periods of ED crowding. The discussion led to the identification of 4 areas of interrogation and key research priorities in each of 4 areas considered to be critical components of a progressive research agenda for improving ED efficiency. The 4 areas of interrogation identified are:

- What measures can be used to understand and improve efficiency and quality of efficiency in the emergency department?
- Which factors outside of the emergency department's control affect ED efficiency?
- How do workforce factors affect ED efficiency?
- How do ED design, patient flow structures, and use of technology affect efficiency?

The authors proposed that research aimed at filling the knowledge gaps in these 4 areas of inquiry is necessary to identify evidence-based interventions that are effective at improving efficiency in the emergency department.

Discussion

ED crowding is an important issue in today's health care system. Because the need for health care services is expected to increase as the population continues to age, the issue of ED crowding will become even more important. Since the 2006 IOM report The Future of Emergency Care, ED crowding has been at the forefront of the health care discussion.[29] Although this literature review presents an overview of ED crowding as a problem continuing to affect health care facilities nationwide, the review also highlights

the need for further study to gain a better understanding of this very complex phenomenon. The progress made thus far is promising and illustrates the need for scientific evaluation of interventions to reach consensus regarding best practices related to improving ED crowding and efficiency. Although progress pertaining to gaining consensus on ED crowding metrics has been achieved,[14] a gap in the literature remains with regard to performance improvement research aimed at identifying best practices for achieving efficiency in the emergency department and maintaining quality of care during periods of ED crowding.[28]

Conclusion

ED crowding is a multifaceted problem that requires shared accountability for the problem by multiple interdepartmental leaders within a hospital system. It is important for ED leaders to continue to work on improving ED efficiency to further reduce the burden of ED crowding. On a professional level, health care leaders can strive to adopt and diffuse an interdisciplinary consensus statement articulating a consistent definition for ED congestion and metrics exemplifying when ED congestion is occurring. Further, it is the charge of emergency health care professionals to conduct rigorous research and performance improvement studies to reduce ED crowding and disseminate evidence-based solutions.

REFERENCES

1. American College of Emergency Physicians. Emergency department crowding information paper. http://www.acep.org/clinical-practice-management/emergency-department-crowding/. Accessed January 16, 2013.
2. Richardson LD, Asplin BR, Lowe RA. Emergency department crowding as a health policy issue: past developments, future directions. *Ann Emerg Med.* 2002;40:388-93.
3. United States General Accounting Office. Hospital emergency departments: crowded conditions vary among hospitals and communities (GAO publication No. 03-460). http://www.gao.gov/products/GAO-03-460. Accessed January 16, 2013.
4. United States General Accounting Office. Hospital emergency departments: crowding continues to occur, and some patients wait longer than recommended time frames (GAO publication No. 09-347). http://www.gao.gov/products/GAO-09-347. Accessed January 16, 2013.
5. Richards JR, Navarro ML, Derlet RW. Survey of directors of emergency departments in California on overcrowding. *West J Med.* 2000;172:385-8.
6. Solberg LI, Asplin BR, Weinick RM, Magid DJ. Emergency department crowding: consensus development of potential measures. *Ann Emerg Med.* 2003;42:824-34.
7. Begley CE, Chang Y, Wood R, Weltge A. Emergency department diversion and trauma mortality: evidence from Housto Texas. *J Trauma.* 2004;57:1260-5.
8. Bernstein SL, Verghese V, Leung W, Lunney AT, Perez I. Development and validation of a new index to measure emergency department crowding. *Acad Emerg Med.* 2003;10:938-42.
9. Schneider SM, Gallery MS, Schafermeyer R, Zwemer FL. Emergency department crowding: a point in time. *Ann Emerg Med.* 2003;42:167-72.
10. Weiss SJ, Arndahl J, Ernst AA, Derlet R, Richards J, Nick TG. Development of a site sampling form for evaluation of ED overcrowding. *Med Sci Monitor.* 2002;8:CR549-53.
11. Weiss SJ, Derlet R, Arndahl J. Estimating the degree of emergency department overcrowding in academic medical centers: results of the National ED Overcrowding Study (NEDOCS). *Acad Emerg Med.* 2004;11:38-50.
12. Weiss SJ, Ernst AA, Derlet R, King R, Bair A, Nick TG. Relationship between the national ED crowding scale and the number of patients who leave without being seen in an academic ED. *Am J Emerg Med.* 2005;23:288-94.
13. Eckstein M, Chan LS. The effect of emergency department crowding on paramedic ambulance availability. *Ann Emerg Med.* 2004;43:100-5.
14. Emergency Nurses Association. Development of Consensus Statement on Definitions for Consistent Emergency Department Metrics. *J Emerg Nurs.* 2012;38:270-2.
15. Laskowski-Jones L. Starling's curve: a way to conceptualize emergency department overcrowding. *J Emerg Nurs.* 2005;31:229-30.
16. Asplin BR, Magid DJ, Rhodes KV, Solberg LI, Lurie N, Camargo CA. A conceptual model of emergency department crowding. *Ann Emerg Med.* 2003;42:173-80.
17. Haraden C, Resar R. Patient flow in hospitals: understanding and controlling it better. *Front Health Serv Manage.* 2004;20:3-15.
18. Institute for Healthcare Improvement. Optimizing patient flow: moving patients smoothly through acute care settingsInstitute for Healthcare Improvement; 2003.
19. The Joint Commission. Focus on five: strategies for implementing the new patient flow standard. *Jt Comm Perspect Patient Saf.* 2005;5:11.
20. Litvak E, Buerhas PI, Davidoff F, Long MC, McManus ML, Berwick DM. Managing unnecessary variability in patient demand to reduce nursing stress and improve patient safety. *Jt Comm J Qual Patient Saf.* 2005;31:330-8.
21. Brideau LP. Flow: why does it matter? *Front Health Serv Manage.* 2004;20:47-50.
22. Regenstein M, Nolan L, Wilson M, Mead H, Siegel B. Walking a tightrope: the safety of the safety net in ten U.S. communities. http://urgentmatters.org/media/file/UrgentMatters_Walking_A_Tightrope.pdf. Accessed January 16, 2013.
23. McClelland MS, Lazar D, Sears V, Wilson M, Siegel B, Pines JM. The past, present, and future of urgent matters: lessons learned from a decade of emergency department flow improvement. *Acad Emerg Med.* 2011;18:1392-9.

24. Wilson MJ, Siegel B, Williams M. Perfecting patient flow: America's safety net hospitals and emergency department crowding. National Association of Public Hospitals and Health Systems; 2005.
25. McManus ML, Long MC, Cooper A, Litvak E. Queuing theory accurately models the need for critical care resources. *Anesthesiology.* 2004;100:1271-6.
26. Bellow AA, Jr, Flottemesch TJ, Gillespie GL. Application of the Emergency Department Census Model. *Adv Emerg Nurs J.* 2012;34: 55-64.
27. Pines JM, McCarthy ML. Executive summary: interventions to improve quality in the crowded emergency department. *Acad Emerg Med.* 2011;18:1229-33.
28. Ward MJ, Farley H, Khare RK. Achieving efficiency in crowded emergency departments: a research agenda. *Acad Emerg Med.* 2011;18: 1303-12.
29. Institute of Medicine. Hospital-based emergency care: at the breaking point. http://www.iom.edu/Reports/2006/Hospital-Based-Emergency-Care-At-the-Breaking-Point.aspx. Accessed January 16, 2013.